The bean method as a tool to measure sensitive behavior

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Introducing the bean method as a tool to measure sensitive behaviour

ABSTRACT

Conservationists need to measure human behaviour to guide decisions and evaluate their impact. However, activities can be misreported and reporting accuracy might change following conservation interventions, making it hard to verify any apparent changes. Techniques for asking sensitive questions are increasingly integrated into survey designs to improve data quality but some can be costly or hard for non-experts to implement. We demonstrate a straightforward, low-cost approach, the "bean method" in which respondents give anonymous answers by adding a coloured bean to a jar to denote a yes or no response. We apply the bean method to measure wildmeat hunting and trading over two years at a conservation project site in Gola Forest, Liberia, and extend the technique to accommodate questions about hunting frequency. We compare responses given using the bean method and direct questions, for groups that did and did not participate in conservation interventions. Results from the bean method corresponded to those from direct reports, giving no indication of change in question sensitivity following conservation interventions. Estimates from both methods indicate that wildmeat trading decreased in project and non-project households (from 36% to 20%), while hunting decreased in one project group (38% to 28%). Where inconsistent answers were given (2 to 6% of respondents), differences were in both directions and were most likely attributable to measurement error. The bean method was quick and straightforward to administer in a low-

literacy setting. We show it can be modified for answers of more than two categories and consider it a valuable tool that could be adapted for a wide range of conservation settings.

INTRODUCTION

Where conservation interventions aim to influence human behaviour, it is essential to measure behaviour-change impacts and build an evidence base to guide decisions (Schultz, 2011). However, behaviours of interest to conservationists are often illegal, making them challenging to study (Gavin et al., 2010). One problem is social desirability bias: systematic error introduced when people inaccurately report behaviour in order to convey a more socially desirable image (Krumpal, 2013). Such bias can lead to under-reporting of sensitive activities or over-reporting of desirable behaviour (Tourangeau and Yan, 2007). It presents a particular problem for evaluating conservation impacts, since many interventions explicitly aim to alter the social desirability of behaviour, for instance through education or social marketing campaigns (Salazar et al., 2019). Consequently, data collected before and after interventions may have different degrees of misreporting, making it hard to identify genuine changes. The issue that sensitive behaviour may be misreported has led to increased use by conservationists of survey methods explicitly designed to address this (Nuno and St. John, 2015).

A growing body of research applies specialised questioning techniques to understand sensitive conservation behaviours (e.g. Fairbrass et al., 2016; Hinsley et al., 2019; Nuno and St John, 2014; St John et al., 2014, 2012; Travers et al., 2019). These techniques are designed to encourage truthful reporting by protecting anonymity of respondents and ensuring researchers cannot link behaviour directly to individuals (Nuno and St. John, 2015). Two well-known approaches are the randomised response technique (Warner, 1965) and unmatched count technique (Droitcour et al 1991), but a variety of other methods have been developed and applied in conservation settings (Nuno and St. John, 2015; St. John et al., 2010). Studies comparing estimates from specialised methods to those resulting from asking questions directly, offer insight into the performance of different approaches (Razafimanahaka et al., 2012) and provide evidence that specialised techniques can increase reporting of sensitive topics (Lensvelt-Mulders et al., 2005; Phillips et al., 2010). However, many specialised techniques are statistically inefficient, requiring large sample sizes (Hinsley et al., 2019), can be cumbersome for respondents and enumerators, and require advanced statistical approaches to analyse and interpret results. If the sensitivity of the activity under investigation is initially low, specialised techniques may unnecessarily complicate monitoring data, wasting valuable resources (Hinsley et al., 2019). Further, complex techniques can introduce new sources of error, such as whether respondents or interviewers follow instructions correctly (Davis et al., 2019; Lensvelt-Mulders et al., 2005). Nevertheless, specialised questioning methods have proven effective to understand illegal conservation activities which are otherwise challenging to measure (e.g. Nuno et al., 2013; Razafimanahaka et al., 2012). Development of straightforward, low-cost techniques would further enable conservationists to measure sensitive behaviour across a wider range of settings.

The bean method, developed by Lau et al (2011), may meet these criteria but to our knowledge, has yet to be used in conservation. The bean method employs a basic system whereby respondents report their ‘yes’ or ‘no’ answer by placing a bean (or counter) of specified colour (e.g. black=yes, red=no) into a container which already contains a known number beans of those colours. Interviewers do not observe participants moving beans but count the beans after each day or survey block, to obtain group-level estimates. Investigating sexual behaviour, Lau et al (2011) found the bean method gave prevalence estimates up to 10% greater than direct reports. The method has limitations, for example it provides only group-level estimates, so cannot be used to investigate drivers of individuals’ behaviour, and its original formulation allows only a limited number of binary (e.g. yes-no) questions to be asked. However, it is straightforward and cheap to administer, raw results are easy to interpret, and it can be appended to questionnaire-based surveys to generate insight into social desirability bias without significantly increasing data collection costs. Materials can be locally sourced, making it particularly appropriate for settings where complex approaches are likely to be viewed with suspicion. The bean method has received little attention since its development (but see Cerri et al., 2017), but similar approaches have been successfully used to measure sensitive health behaviours in low-literacy populations (Lowndes et al 2012) .

Here we apply the bean method alongside direct questions to measure wildmeat hunting and trading at a conservation project site in Gola Forest, Liberia. Wildlife is hunted across Liberia providing an income source for hunters, traders who transport dried meat to urban markets, and marketeers who sell to consumers (Jones et al., 2019). It is widely consumed, particularly in rural areas where it represents a relatively affordable protein source (Ordaz-Németh et al., 2017). National laws prohibit unlicensed hunting, hunting in protected areas and killing of protected species (National Wildlife Act, 2016), but are not widely enforced. Hunting-reduction interventions implemented by conservation projects could be expected to increase under-reporting of hunting and trading. To explore this, we compare estimates from the bean method and direct questions, before and after implementation of hunting-reduction interventions, and for groups that did and did not receive interventions. We extend the method to measure frequency of activities by allowing answers in more than two categories. This study focuses on the application of the bean method as a tool to measure behaviour, and evaluation of the impacts of interventions will be presented elsewhere.

METHODS

Study site

The study was conducted at the site of an ongoing conservation project, GolaMA, implemented by the Society for Conservation of Nature in Liberia and the Royal Society for the Protection of Birds. GolaMA aims to reduce wildmeat hunting and trading in community forests through community-based management, while improving income from conservation-friendly livelihoods. The project works with two neighbouring administrative units, or clans (henceforth 'group 1' and 'group 2'), supporting each to establish their own community-managed forest. The two clans share similar socio-demographic profiles, with subsistence rice farming being the predominant livelihood activity (Supporting Information). At the first round of data collection, project interventions specifically targeting wildmeat hunting and trading had not been implemented and project activities had focussed on socio-economic surveys, resource management workshops, and pilot phases of livelihood support work. By the second round of data collection, livelihood support programmes had been implemented across all households, consisting of training to increase agricultural yields, introduction of bee-keeping, small-loans schemes providing access to low-interest credit, and adult literacy classes. There had also been initial work supporting small-scale miners to improve revenues. Participants in all livelihood programmes made formal agreements to refrain from commercial wildmeat hunting or trading. Workshops and meetings were conducted to inform people about existing hunting regulations and conservation management. All interventions were applied across the two clans that participated in GolaMA, with minor differences in timing of implementation. During the study, non-project conservation activities took place, relating to boundary demarcation of the Gola Forest National Park, which borders the project site. These included increased ranger patrols and confiscation of wildmeat at a roadblock along the road to Monrovia. Small-scale mining is prohibited within the park but mining in community forest is not regulated by park rangers. By contrast, wildmeat could be confiscated by rangers regardless of where hunting occurred.

Wildmeat hunting and trading were socially acceptable activities about which people spoke freely (Jones et al., 2019). Nevertheless, some degree of social desirability bias could be expected given many hunters (45%, n=130) and traders (71%, n=36) reported incurring penalties in the past (Jones et al., 2019a). Small-scale mining was openly practised but often without legally required licenses.

Survey methods

The bean method was applied alongside direct questions in a single questionnaire administered to households during face-to-face interviews. The questionnaire was administered during two time periods: the initial phases of GolaMA (February to July 2017), and the projects' final year (February to March 2019). The sample in each of the two survey periods comprised a complete census of all households in villages belonging to two clans that participated in GolaMA (group 1 and group 2), and in three villages in neighbouring, non-participating clans (non-project group). The same households were targeted in each survey period. The two clans participating in the golaMA project are considered separately as group 1 (nine villages) and group 2 (six villages) to give results which are informative for project managers, and to account for differing livelihood patterns between clans (see Supporting Information).

The questionnaire measured prevalence for behaviours targeted by conservation interventions (wildmeat hunting and trading) which could be expected to decrease in prevalence and increase in sensitivity due to project implementation. A non-target behaviour (small-scale mining) was also measured, providing a comparison with an activity supported by the project. Small-scale mining was not expected to become more sensitive or less prevalent during the study. In contrast to hunting, project activities aimed to support, not restrict, mining activities (see Supporting Information), and law enforcement by park rangers related only to mining within the protected area which was unlikely to affect miners in our study as these operated almost entirely within community forests. Frequency of hunting and wildmeat selling were measured using an extension of the bean method (see below). Prevalence and frequency estimates obtained from the bean method were compared to those obtained via direct questions. Further, inconsistency of responses was evaluated to assess minimum levels of misreporting.

The questionnaire was administered to the most senior household member present and had five sections (Supporting Information). Starting and ending times of interviews were recorded. Section one consisted of basic socio-demographic questions. In section two, respondents were directly asked, for each of 12 livelihood activities, whether any household member had engaged in the activity over the past six months. Activities included hunting, wildmeat trading and mining alongside other common activities such as farming, charcoal production and fishing. In section three, the bean method (see below) was applied to ask if any household member had engaged in hunting, wildmeat trading and mining during the same six-month period. In section four, a modified form of the bean method (see below) was applied to ask two questions: the number of days any household member had been hunting during the previous week, and number of carcasses sold in the previous week up to a maximum of ten. In the final section, respondents were directly asked the same two questions about frequency of hunting and carcasses sold. For frequency questions, an important consideration was that counting and moving beans would become obvious for large numeric responses. A week timeframe was therefore chosen to limit possible hunting days to seven, and carcass sales were capped at ten. Respondents may be less likely to recall activities over longer time periods, and weekly religious observances provided temporal reference points.

Free, prior and informed consent was given verbally by all respondents. Respondents were informed that the study sought to understand livelihood activities, the answers they provided would be confidential, and results of the study would be published. Specific permission to conduct the survey in each village was obtained from clan and village authorities. Ethical approval for the study was given by Royal Holloway University of London ethics committee.

The bean method

The bean method was applied as follows. Respondents were asked to provide ‘yes’ or ‘no’ answers by taking a bean of a specified colour/type from a ‘selection container’ and placing it in an ‘answer container’ (Fig. 1). Prior to asking each question, the interviewer demonstrated which type of bean signified a ‘no’ answer, which would signify ‘yes’, and checked the respondent understood by asking them to demonstrate their choice of bean for a dummy question about a non-sensitive topic. The interviewer then asked the sensitive question, turning around so they could not observe the respondent’s bean choice. Three questions were asked with this method, with a different type of bean signifying ‘yes’ for each question, and the same type of bean signifying ‘no’ for any question. One ‘answer container’ and one ‘selection container’ were used for these three questions.

Locally sourced containers and beans were used (Fig. 1). The ‘selection container’ was a large (approx. 1 litre) plastic cup, inside which we placed an opaque plastic bag half-filled with an even mixture of five different types of bean. The cup had a broad opening allowing respondents to easily see inside to select beans, and the plastic bag allowed them to further conceal their selection by using it to completely cover their hand. The ‘answer container’ was a clear plastic jar (approx. 1 litre) with a label around the centre and filled approximately one-third of the way with an even mix of the five different types of beans. Respondents could clearly see there were many beans in the jar already, and the label concealed the area in which a respondent’s bean landed. Five types of bean were used (Fig. 1): red kidney beans (type “a”) were used to denote a ‘no’ answer to any question; square white beans (type “b”) denoted ‘yes’ to the first question (‘has anyone in your household engaged in wildmeat trade in the past 6 months’); flat mottled beans (type “d”) denoted ‘yes’ to the second question (‘has anyone...engaged in hunting’); and pink and white beans (type “e”) denoted ‘yes’ to the third question (‘has anyone...engaged in mining’). The fifth ‘bean’ was a dark brown seed (type “c”) of a similar size and was included to indicate method comprehension; the quantity of this bean in both containers should remain constant as it was not associated with answering questions. At the start of each day, the answer container held 50 of each type of bean. The selection container had approximately twice this number.

Surveys were conducted by two teams of one or two trained interviewers, who were local residents in one of the study villages. Where possible at least one female interviewer was on each team. Beans were counted by each survey team at the end of each day, and no more than 35 households were surveyed in a day to limit potential mistakes during counting. For small villages, a survey-day included all households in the village (range = one to 30 households). In large villages, households were surveyed over multiple days, or by more than one team. To ensure respondent protection, we do not report data at the village level (St.John et al., 2016).

The modified bean method for more than two categories

We adapted the bean method described above to obtain estimates for frequency of hunting and selling wildmeat. A separate answer container was used for frequency questions with the same appearance as the yes-no answer container. The same selection container was used for both yes-no and frequency questions. Respondents were instructed to answer frequency questions by moving a number of beans into the answer container, with a separate colour denoting an answer of 0. For the first question, 'how many days has anyone in your household been hunting in the past week?', 0 answers were denoted by bean type "a" (Fig 1A) and the number of days was indicated by bean type "b". For the second question, 'how many carcasses has anyone in your household sold in the past week?', 0 answers were denoted by bean type "c", and number of carcasses denoted by bean type "d". To limit the amount of counting for high answers, respondents were instructed to move 10 beans for answers of 10 or greater. The bean method was modified during the first survey period to distinguish between zero answers given to each frequency question. In the initial version, administered in 2017 in five villages, the same colour of bean was used to denote zero answers for both frequency questions. This was then changed so zero answers to each frequency question were denoted by different colours. Proportion of households engaged in hunting or meat selling in the previous week could therefore not be calculated from the bean method in 2017 for the non-project group and group 1.

Evaluation of methods

Prevalence of hunting, trading and mining across households was estimated in each survey period as proportion of respondents answering ‘yes’ to direct and bean method questions respectively. Prevalence was calculated separately for each clan (“group 1” and “group 2”) that participated in the GolaMA project, and for the non-project group.

Frequency of hunting and wildmeat selling was measured as number of days any household member had been hunting in the previous week, and number of carcasses sold by any household member in the previous week. Average number of days hunting and carcasses sold was calculated across all households, and among only households that had engaged in the activity in the previous week. The proportion of households who engaged in either activity in the previous week was the proportion of non-zero answers.

For all estimates, 95% confidence intervals were calculated as S.E.*1.96. However, for bean method responses to frequency questions, individuals’ answers are unknown. Therefore, mean response for each survey-day was used to calculate standard errors, and the sample size was taken to be number of survey-days. This approach fails to account for variable numbers of respondents in each survey-day, so provides only rough approximation.

To evaluate inconsistency between answers obtained through the bean method and direct questions, the difference in 'yes' answers from each method was calculated for each survey-day. For frequency questions, we calculated difference in mean answer per household for each survey-day. Direct responses for frequency of carcass-selling frequency were capped at ten carcasses per respondent for comparison with the bean method.

RESULTS

There were 480 households in total in the study area during the first round of data collection (2017); 475 participated fully, one household abstained and four gave incomplete answers. During the second round (2019), there were 524 households all giving complete answers. The same households were targeted in both rounds of data collection, so differences in sample sizes between years reflect socio-demographic processes (e.g. migration, marriage). Sample sizes were similar for each of the two clans that participated in the GolaMA project (group 1 and group 2) and the households from non-project villages (non-project group). In 2017, number of respondents (households) in group 1, group 2 and the non-project group were 201, 136 and 143 in 2017, and 181, 168 and 175 in 2019. Average respondent age was 40.7±14.5SD (2017) and 41.3±14.0SD (2019), with 49% and 48% male respondents. Household sizes, respondent ages, gender and marital status were similar across groups and survey periods (Supporting

Information). Number of respondents per survey-day ranged from one to 31 in 2017 (mean=15.0) and two to 34 in 2019 (mean=12.8). Lower limits reflect village sizes. The questionnaire took an average of 9.5 minutes to administer (n=975, SD=3.8).

Prevalence of hunting, wildmeat trading and mining

The proportion of households reporting hunting via direct questions did not change from 2017 to 2019 in the non-project group (Fig. 2), increased slightly in group 1 and decreased in group 2. Across all groups hunting was reported by 39%[35-44%, 95%CI] of households in 2017, and 38%[34-42%] in 2019. Trading prevalence was lower in 2019 than 2017 in all groups, decreasing from 36%[31-40%] of all households in 2017 to 20%[17-24%] in 2019. Mining prevalence changed little overall excepting an increase in group 1, from 23%[17-28%] to 31%[24-38%].

Responses from the bean method indicated similar prevalence and patterns as direct questions (Fig. 2). Differences between the methods were inconsistent, varying across groups and years. For instance, in 2017 hunting prevalence appeared lower with the bean method than direct questions in group 1 but not group 2, whereas in 2019 estimates were similar or lower for all groups. Methods produced similar mining estimates, excepting group 2 which showed higher bean method estimates in 2017, then lower in 2019. Frequency of the bean type added to check question comprehension stayed constant for all survey-days, indicating it was not erroneously selected by respondents.

Frequency of hunting and wildmeat selling

Mean days spent hunting during the previous week decreased in group 2 from 1.03[0.73-1.33 95%CI] in 2017 to 0.54[0.36-0.71] in 2019, but changed little in other groups (Fig. 3). Proportion of households that hunted in the previous week followed the same pattern (Supporting Information). Among households that hunted in the previous week, mean days spent hunting decreased slightly across all groups, from 2.79[2.54-3.04] in 2017 to 2.34[2.13-2.54] in 2019 (Supporting Information). Mean carcasses sold per household decreased in all groups from 1.63[1.25-2.01] to 0.76[0.59-0.93], with the greatest change seen in group 2 (Fig. 3). The proportion of households selling wildmeat in the previous week decreased only in group 2 (from 37%[29-45%] to 17%[11-22%]; Supporting Information). Among households selling wildmeat in the previous week, average number of carcasses sold was higher in 2017 (5.73[5.02-6.45]) than 2019 (3.13[2.78-3.48]) with the largest difference in group 2 (Supporting Information).

Reported hunting and meat-selling frequency was similar for the modified bean method as direct questions, and differences between methods were inconsistent across survey groups and years (Fig. 3). This was also the case for the proportion of households that had hunted or sold meat in the previous week, and average frequencies per household that had hunted or traded (Supporting Information).

Inconsistency between answers to direct questions and the bean method

A small percentage of respondents gave inconsistent answers to the same question asked directly or with the bean method (2 to 6%; Table 1). Inconsistency occurred in both directions, was similar across questions and slightly higher in 2019 than 2017 for all questions. The highest proportion of inconsistent answers was 12% (group 2, 2017; Table 1). Responses to questions about the number of days' hunting and carcasses sold in the previous week showed slight inconsistency that followed the same pattern as yes-no questions (Supporting Information). Survey-day differences ranged from 0 to 1.25 hunting days/respondent (2017 mean=0.08$\pm$0.16SD, n=32 survey-days; 2019 mean=0.07$\pm$0.23SD, n=41 survey-days) and 0 to 3.80 carcasses/respondent (2017 mean=0.23$\pm$0.72SD, 2019 mean=0.03$\pm$0.12SD).

DISCUSSION

This study explored the potential of the bean method as a tool to measure sensitive behaviour. Results showed no consistent difference between answers given anonymously through the bean method or directly, either before or after conservation interventions. This suggested that sensitivity of hunting and trading behaviour remained low, or that under-reporting was similar across both methods. Both methods indicated a decrease in wildmeat trading across all households, while hunting changed little overall. As with any approach, accuracy of either direct questions or the bean method remains unknown and both face several sources of measurement error. However, our findings highlight useful properties of the bean method: it was low-cost, quick and straightforward to implement, appropriate for low-literacy populations, materials could be locally sourced, and raw results could be immediately interpreted without statistical manipulation.

Bean method results agreed closely with those from direct questions, for all groups and survey periods. This could indicate that mistrust and associated under-reporting remained undetected, or alternatively, that questions were not sensitive. We believe the latter is likely for several reasons. First, previous work found hunters and traders freely discussed their activities despite having experienced wildmeat confiscation (Jones et al., 2019). Second, motivation to under-report behaviour might have remained low: the conservation project did not implement penalties and questions applied to all household members, not individuals, minimising personal risks. Finally, interviewers were local citizens, potentially reducing respondents' suspicion or promoting perceptions that falsehoods would be detected (Weinreb, 2006). Given this apparently low sensitivity of behaviours in our study, a question remains whether the bean method promotes truthful reporting of sensitive topics. Previous results suggest it can be effective in some cases: Lau *et al.* (2011) found reporting of risky sexual behaviours increased with the bean method in four out of five surveys, relative to direct questions, while Cerri *et al.* (2017) found higher reporting for two out of four illegal fishing activities. Neither study found reporting to be lower with the bean method.

Application of more than one questioning format can generate insight into data quality (Anglewicz et al., 2013), and the bean method was useful in this regard. Responses were largely consistent between methods and misreporting showed no systematic patterns, suggesting inconsistent answers represented background measurement error which may be unrelated to question sensitivity and could affect either method. Self-reported information can be influenced by factors such as contextual cues which alter how questions are interpreted, the cognitive process of recalling information, interviewer-respondent dynamics, the previous exposure of respondents to surveys and interviewer experience (Burton and Blair, 1991; Schwarz, 2007; West and Blom, 2017). In our study, direct questions were situated within a list of livelihood activities while bean method questions were not, potentially influencing question interpretation. The process of counting beans could positively affect accuracy of answers to frequency questions. For example, the visual prompt may reduce recall error (Burton and Blair, 1991) or people's tendency to round answers to values ending in zero or five (Vaske et al., 2006). More respondents gave consistent answers in the second survey than the first, and the same households were targeted in each survey round. This is consistent with findings that response reliability is highest where respondents have previously participated in surveys, and among interviewers with previous survey experience (Wolter and Preisendörfer, 2013).

The bean method could be a useful addition to the range of specialised questioning techniques used in conservation. Other straightforward approaches, such as the ballot box method, can be unsuitable in low-literacy settings (Bova et al., 2018), or may require extensive pre-testing, as for the unmatched count technique (Hinsley et al., 2019). Complex approaches, such as the randomised response technique, can be time-consuming for interviewers and respondents to comprehend (Davis et al., 2019), and can create suspicion among respondents (Bova et al., 2018), whereas we found the bean method was well-received, quick to administer and interviewers required little additional training. Unlike probability-based approaches, bean method results can be immediately interpreted which is useful for community-based management (Turreira-García et al., 2018). Relative to the unmatched count technique or the randomised response technique, the bean method may be better suited for small sample sizes or behaviours with low prevalence (Hinsley et al., 2019; Lensvelt-Mulders et al., 2005). However, unlike these approaches the bean method cannot be used to explore individual-scale drivers. Additionally, respondent error or counting mistakes have not been evaluated, but these could inflate estimates of low-prevalence behaviours.

Limitations of the bean method include that only a restricted number of questions can be asked and only group-level estimates are generated. We found that answers of more than two categories can be accommodated but the range of values is constrained since counting large numbers of beans could become conspicuous and demanding. There also remains the technically challenging issue of estimating confidence intervals for frequency questions. Importantly, care is needed to ensure respondents are fully protected (St.John et al., 2016). For instance, a small village in our study had only one respondent whose answer was identifiable. Similarly, if all individuals in a survey-day give identical responses then answers are not anonymous. Ensuring a minimum sample size is reached before beans are counted, and avoiding generating village-level results, would help address respondent protection issues. Further work could be usefully directed at quantifying sources of error, improving methods for estimating uncertainty and assessing how details of survey administration affect results. For instance, having given a direct answer, respondents may give the same answer with the bean method in order to maintain consistency, whether or not it was truthful. When we asked respondents with only one method (either directly of the bean method), behaviour was reported at similar levels (Supporting Information), but larger sample sizes are needed to verify this pattern.

Our study did not aim to assess effectiveness of hunting-reduction efforts. However, insights from the results are worth highlighting, as both methods indicated wildmeat trading decreased across project and non-project households. Reports of local residents suggested law enforcement at a roadblock prompted some traders to abandon their activities. Jones et al., (2019a) found a high proportion of traders from project and non-project villages relied on transporting meat through this roadblock, and cited meat confiscation as a motive for reducing trading activities. Hunters, meanwhile, faced lower financial losses from confiscations and often sold meat to non-local traders who utilised alternative transport routes (Jones et al., 2019), possibly explaining why hunting showed little decrease. Notably, villages closest to the roadblock reported larger declines in both trading and hunting. Bean method results were useful as additional information to help managers assess the likelihood that these trends were genuine rather than being due to under-reporting (A. Gardner, *pers. comm*).

Our case-study illustrates that the bean method is a practical tool which could be valuable for measuring conservation behaviours. Although questions in our study were not apparently sensitive, the method provided useful insight into response reliability by revealing consistency of answers under alternative questioning modes, and helped managers to interpret survey results. More work is needed to evaluate its performance for measuring sensitive topics. However, the bean method has practical advantages of being low-cost and straightforward to implement and we consider there is scope to adapt and extend the method to a wide variety of contexts.

Supporting Information

Background information about the study site and GolaMA project (Appendix S1), socio-demographic descriptions of households (Appendix S2), comparisons between responses to frequency questions given using the modified bean method and direct questions (Appendix S3), results of frequency questions (Appendix S4), results from separate administration of the bean method and direct questions (Appendix S5) and the survey questionnaire (Appendix S6) are available online.

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TABLES

Table 1. Consistency of answers to yes-no questions when respondents were asked directly and through the bean method: the percentage of consistent responses (Same answers); the percentage of people reporting ‘yes’ when asked directly but ‘no’ to the bean method (Direct question high); and the percentage of people reporting ‘no’ when asked directly and ‘yes’ to the bean method (Bean method high).

	Group 1		Group 2		Non-project group		All groups	
	2017	2019	2017	2019	2017	2019	2017	2019
n households	201	181	136	168	143	175	480	524
Hunting								
Same answers	94%	96%	92%	96%	97%	99%	94%	97%
Bean method high	1%	1%	4%	2%	0%	1%	2%	1%
Direct question high	5%	3%	4%	2%	3%	1%	4%	2%
Trading								
Same answers	97%	98%	88%	98%	91%	97%	92%	98%
Bean method high	0%	1%	8%	0%	6%	1%	4%	1%
Direct question high	3%	1%	4%	2%	3%	2%	4%	1%
Mining								
Same answers	98%	98%	95%	95%	96%	99%	96%	98%
Bean method high	1%	1%	4%	1%	1%	0%	2%	0%
Direct question high	1%	1%	1%	4%	3%	1%	2%	2%

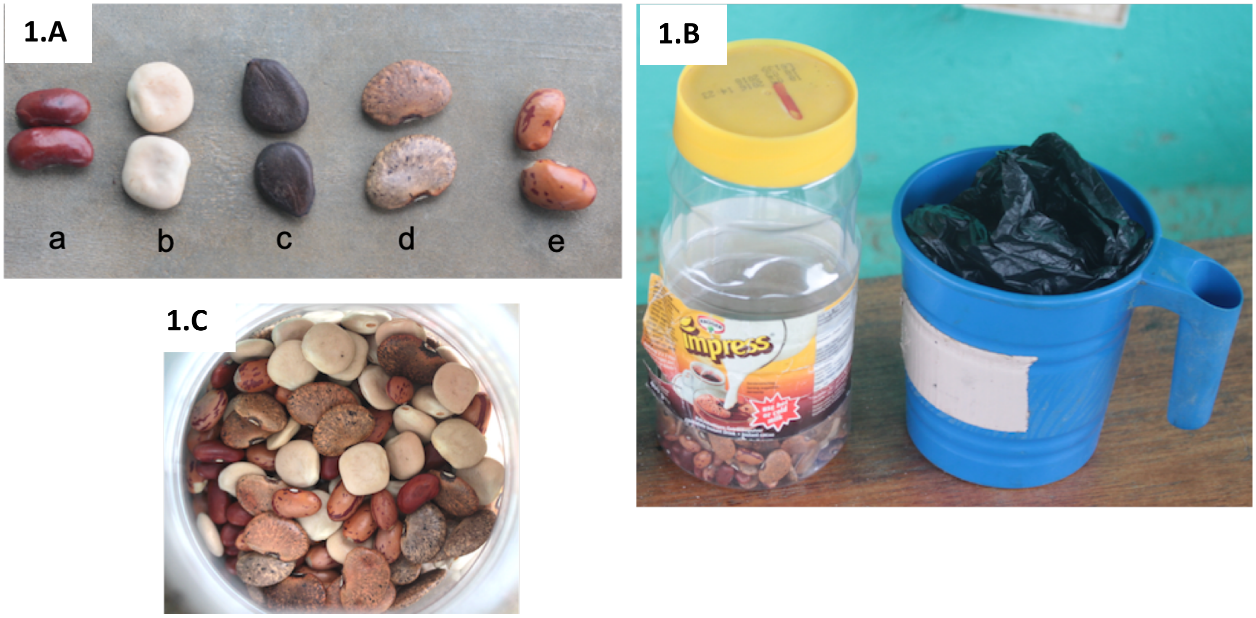
FIGURE LEGENDS

Figure 1. Locally sourced materials used to administer the bean method. 1.A. bean types used to indicate answers: a = no to any question, b = yes to question 1, c does not indicate any answer and is included to check for errors in how well instructions are followed, d = yes to question 2, e = yes to question 3. 1.B. Answer container (left) and selection container (right). Respondents selected their answer from a mixture of beans inside a plastic bag in the selection container. The bag provided additional privacy from onlookers. 1.C. Appearance inside an answer container with a mixture of four bean types.

Figure 2. Prevalence of hunting, trading and small-scale mining across households at the start of a conservation project (squares, n=480) and after two years implementation (triangles, n=524). Values were obtained from the bean method (dashed lines) and direct questions (solid lines), from a complete census of two groups that participated in the project (group 1: red, 9 villages, n_{2017}=201, n_{2019}=181; group 2: green, 6 villages, n_{2017}=136, n_{2019}=168) and a non-project group where conservation activities did not take place (blue, 3 villages, n_{2017}=143, n_{2019}=175). 95% confidence intervals are shown.

Figure 3. Frequency of hunting and sale of wildmeat carcasses across households at the start of a conservation project (squares, n=480) and after two years implementation (triangles, n=524). Values were obtained from direct questions (solid lines) and the modified bean method (dashed lines), from a complete census of two groups that participated in the project (group 1 red, 9 villages, n_{2017}=201, n_{2019}=181; group 2 green, 6 villages, n_{2017}=136, n_{2019}=168) and a non-project group where conservation activities did not take place (blue, 3 villages, n_{2017}=143, n_{2019}=175). Values for carcasses sold are capped at ten per respondent for both methods. Bars indicate 95% confidence intervals, approximated for the bean method as 1.96 * standard error of mean per household values from each survey-day.

FIGURES WITH LEGENDS



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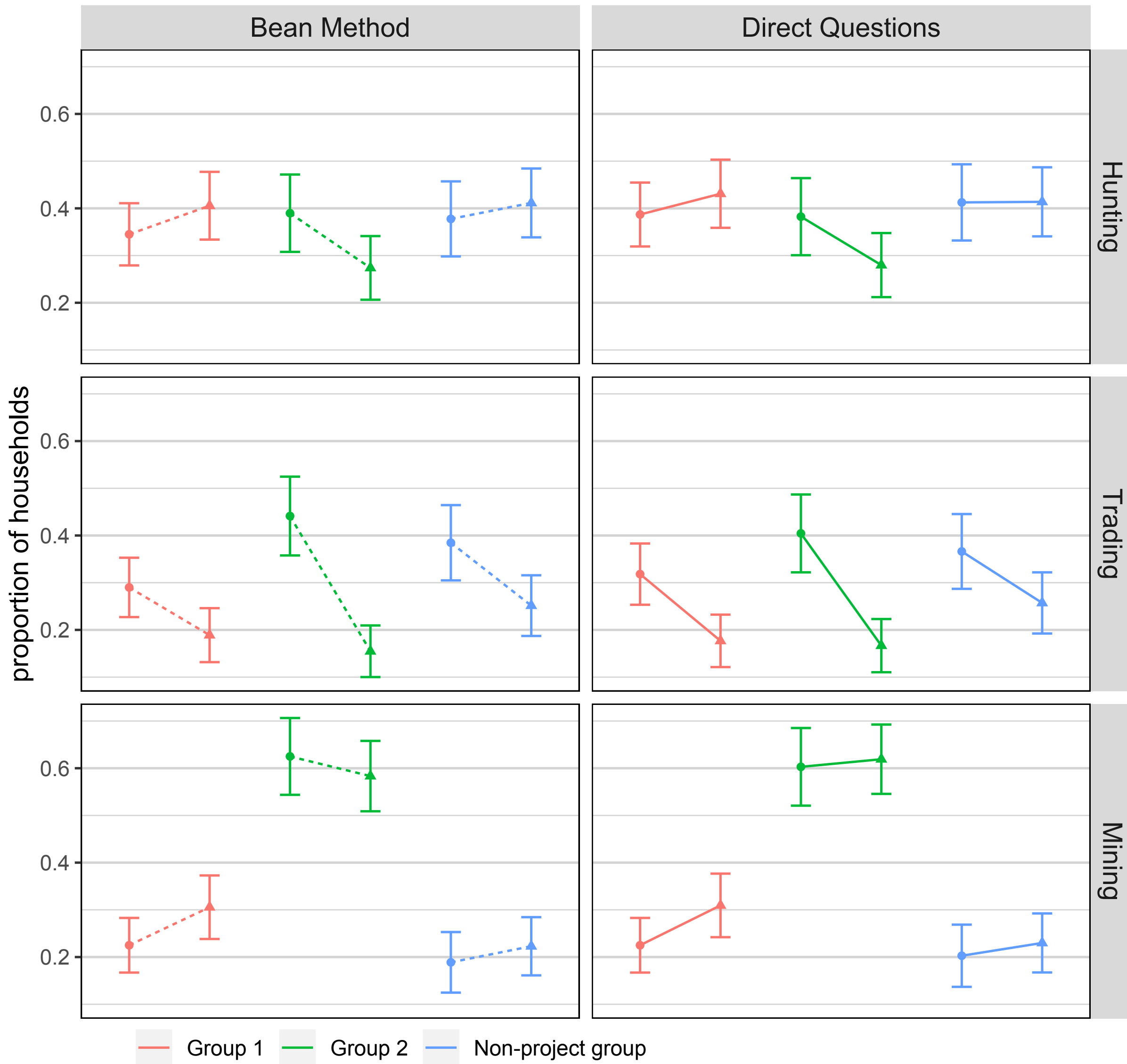

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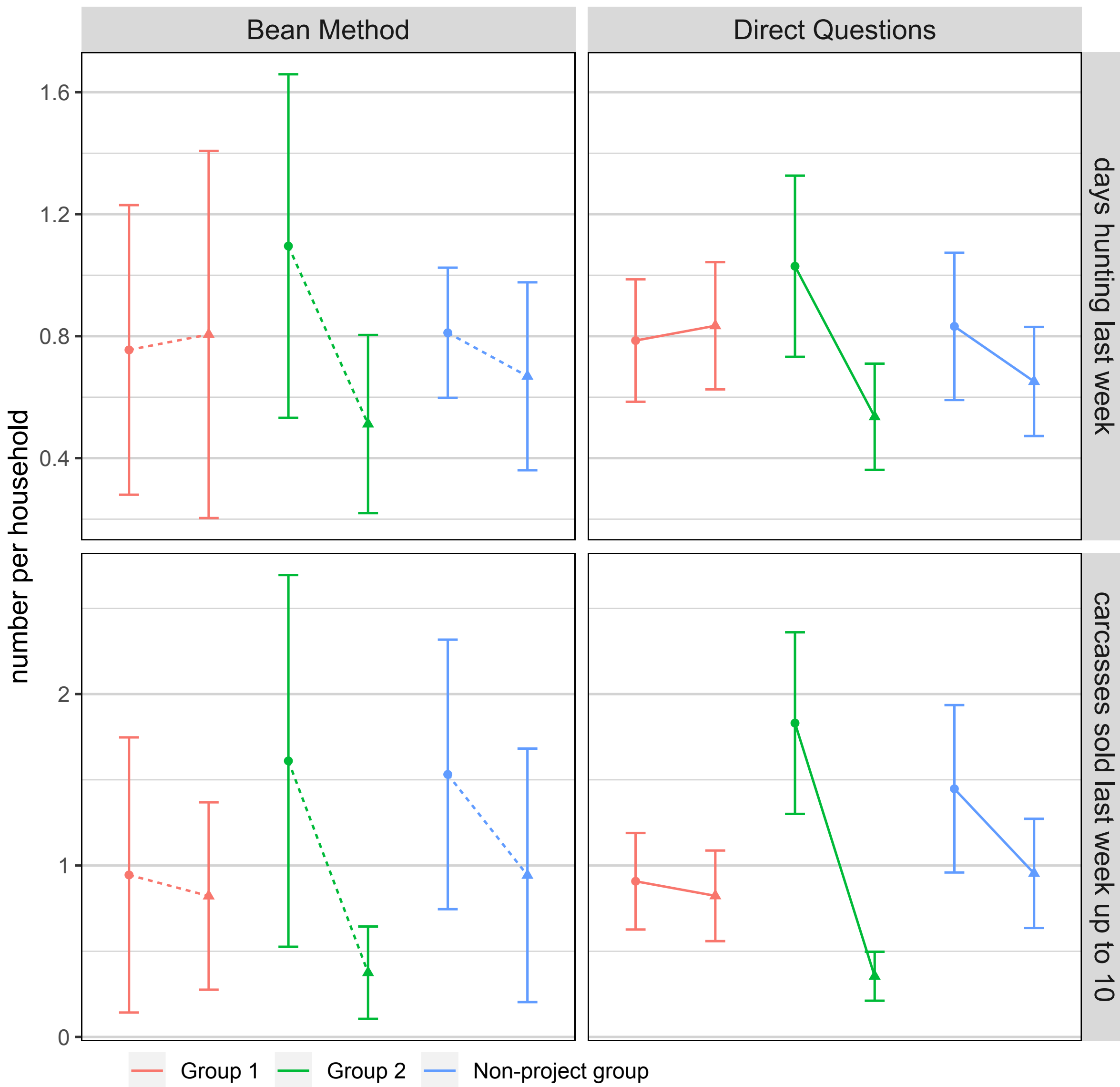

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